

FUNGAL REMAINS FROM THE TERTIARY CARBONACEOUS CLAYS OF TONAKKAL AREA, KERALA

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Abstract

The paper deals with the study of fungal remains from the Tertiary (Miocene) carbonaceous clays of the Tonakkal area of Kerala State, South India. The taxa recorded include 22 genera and 34 species. Of these, 3 species, viz., *Dyadosporonites inaequalis*, *Fusiformisporites tonakkalense* and *Cucurbitariaceites keralaensis* are new. The Tonakkal assemblage shows a number of forms similar to those recorded earlier from the Quilon and Warkalli outcrops of Kerala and the Neyveli lignite of Tamil Nadu, which indicates a correlatable stratigraphic horizon.

Introduction

The paper deals with the study of fossil fungal remains (spores and mycelial shreds) recorded from the carbonaceous clay samples of Tonakkal area in the Trivandrum District of Kerala State in South India.

Tonakkal (Topo sheet; 58 D/14, 8° 37' 30" : 76° 57' 00") is about 30 km north-east of Trivandrum in the drainage basin of the river Attingal. The main rock types of the area are Archaean crystalline rocks, and the Tertiary and the Quaternary sediments, besides laterite derived from the crystalline as well as the Tertiary rocks. The Tertiary sequence in the Tonakkal area is constituted by ferruginous sandstones with clayey intercalations, predominant clay with sandy intercalations, ball clay, carbonaceous clay and peat (see Mallikarjuna & Kapali, 1980).

The material for the present study consists of three carbonaceous clay samples from 9.50 to 10.20 m depth interval of the Tonakkal clay mine.

These clay mine samples studied for their palynological contents have yielded a rich fungal flora (spores, mycelial shreds, fruiting bodies) and scanty occurrence of pteridophytic spores and angiospermous pollen grains.

Earlier, an account exclusively on fungal fruit bodies of this area was presented by Patil and Ramanujam (1980). But as of today, there is no account on the spore and pollen contents of this area. The present study is, therefore, aimed at the detailed study of the fungal spores.

Usual methods of maceration techniques were employed in the recovery of the fungal palynotaxa. The slides were prepared by using either canada balsam or DPX mountant. The unprocessed samples and the slides studied are housed in the palynology laboratory, at the Post-graduate college of Science, Saifabad, Hyderabad.

Systematic Description

Genus—*INAPERTISPORITES* van der Hammen 1954, emend. Sheffy & Dilcher, 1971

Type species—*I. pseudoreticulatus* Rouse, 1959

Inapertisporites sp.

Pl. 1, Fig. 1

Description—Unicelled, inaperturate, elliptical to oval, dark brown, fungal spores; $18-21 \times 8-10 \mu\text{m}$; spore wall $1.5 \mu\text{m}$ thick, psilate.

Genus—*BASIDIOSPORITES* Elsik, 1968

Type species—*B. fournierii* Elsik, 1968

Basidiosporites sp.

Pl. 1, Fig. 3

Description—Spores monoporate, unicellular, elliptical, brownish, $40-42 \times 20-22 \mu\text{m}$; spore wall $1.5 \mu\text{m}$ thick, psilate, basal attachment area conspicuous.

Genus—*DIDYMOPORISPORONITES* Sheffy & Dilcher, 1971

Type species—*D. psilatus* Sheffy & Dilcher, 1971

Didymoporisporonites sp.

Pl. 1, Fig. 4

Description—Oval, 2-celled, dark brown fungal spores; $30-32 \times 20-25 \mu\text{m}$, cells unequal in size. Single pore in smaller cell, larger cell with darker pigment. Septum opaque, $5.5 \mu\text{m}$ wide, spore wall $1.5 \mu\text{m}$ thick, psilate.

Spore Type—A

Pl. 1, Fig. 5

Description—Bicelled, pyriform, nonaperturate, fungal spores; $40-45 \times 28-30 \mu\text{m}$; septate, septum about $4 \mu\text{m}$ thick with a central pore; spore wall $2 \mu\text{m}$ thick, psilate. Basal cell dome-shaped with pointed end and attachment scar. Apical cell hemispherical with rounded end and secondary folds.

Comments—These bicelled, pyriform spore types show close resemblance with the rust spores. Only few specimens are seen in our preparations.

Spore Type—B

Pl. 1, Fig. 6

Description—Spatulate, tetracellate, inaperturate fungal spores; $30-34 \times 10-12 \mu\text{m}$. Spore wall $1.5 \mu\text{m}$ thick, psilate heteroseptate, central septum distinct, about $2 \mu\text{m}$ thick and $6 \mu\text{m}$ long dividing the spore into two equal halves. Each half of the spore is again bicelled, ends bluntly rounded.

Genus—*DYADOSPORONITES* Elsik, 1968

Type species—*D. schwabii* Elsik, 1968

Dyadosporonites inaequalis sp. nov.

Pl. 1, Fig. 7

Holotype—Pl. 1, Fig. 7, 12(A)-1 : 92.10×7.6 ($90.5 \times 22 \mu\text{m}$).

Type Locality—Tonakkal, Kerala, India.

Diagnosis—Spores dicellate, diporate, fusiform, light brown, 89-92 μm long, 22-24 μm wide at the septum. Spore wall double layered, 2 μm thick, psilate; inner layer form double layered septum of uniform thickness dividing the spore into two unequal halves, septum 2-5 μm thick, with 2 pore-like cracks in the middle.

Comments—*Dyadosporonites inaequalis* sp. nov. is characterized by having unequal sized dicellate condition. This spore type is a rarely encountered taxon of the present study.

The genus *Dyadosporonites* is a long range taxon and has been recorded both from Cretaceous and Tertiary deposits (Verma & Rawat, 1963; Clarke, 1965; Elsik, 1968; Ramanujam & Rao, 1978; Jain & Kar, 1979; Ramanujam & Srisailam, 1980).

Affinity—Uncertain.

Genus—*FUSIFORMISPORITES* Rouse, 1959 emend. Elsik, 1968

Type species—*F. crabii* Rouse, 1962

Fusiformisporites tonakkalense sp. nov.

Pl. 1, Fig. 11

Holotype—Pl. 1, Fig. 11, 12(A)-1 : 81.4×10.9 ($51.5 \times 8 \mu\text{m}$).

Type Locality—Tonakkal, Kerala, India.

Diagnosis—Tetracellate, inaperturate, striate, spindle-shaped, brownish fungal spores; $48-52 \times 8-10 \mu\text{m}$. Heteroseptate, central septum 2.5 μm thick, 8 μm long, constricted, imparting a girdle shape to the spore and dividing the spore into two equal halves. Each half with conical outline, pointed ends, septate, septum porate (1 μm wide), with two septal folds, 2.5 μm wide. About 5-6 longitudinal striae are seen on each exposed facet of the spore; striae 1.5 μm wide, not continuous, ends up in the median septum; spore wall 2 μm thick.

Comments—*Fusiformisporites tonakkalense* sp. nov. is characterized by having spindle shape, tetracellate, heteroseptate, striate condition, with pointed ends. The specific name is after the locality. It is a rare element in the present study.

Affinity—Ascomycetes.

Fusiformisporites sp.

Pl. 1, Fig. 10

Description—Spores pyriform, brownish, dicellate, inaperturate; $39-40 \times 20-22 \mu\text{m}$; ends plug-like, bulbous (3.5 μm); transverse septum distinct with 6.5 μm wide shadow band. Spore wall 1.5 μm thick with distinct longitudinal striae numbering about 7-8 on each exposed facet, striae about 2.5 μm thick, not continuous, end up at the septum.

Comments—The specimens of *Fusiformisporites* sp. recorded in the present study are characterized by having pyriform shape with plug-like, bulbous ends.

Genus—*DIPORICELLAESPORITES* Elsik, 1968

Type species—*D. stacyi* Elsik, 1968

Diporicellaesporites sp.

Pl. 1, Fig. 18

Description—Spores elongate, curved-elliptic, tetracellate, dark-brown, diporate, 38-40 \times 10-14 μm . Spore wall 1.5 μm thick, psilate. Cells more or less rectangular (8 \times 4 μm); septa distinct, 1.5 μm thick with triangular septal folds. Apical cells of the spore bluntly rounded, with single slit-like septal pore. Pore simple, invaginated, 1.5 μm wide, rounded.

Genus—*PLURICELLAESPORITES* van der Hammen, 1954 emend. Sheffy & Dilcher, 1971

Type species—*P. typicus* van der Hammen, 1954

Pluricellaesporites sp.

Pl. 1, Fig. 19

Description—Spatulate, dark-brown, fungal spores; 70-75 \times 24-28 μm ; spore wall, 1.5 μm thick, scabrate to granulose; 5 to many celled, central two cells are larger than the rest of the cells.

Genus—*MULTICELLAESPORITES* Elsik, 1968 emend. Sheffy & Dilcher, 1971

Type species—*M. nortonii* Elsik, 1968

Multicellaesporites sp.

Pl. 1, Fig. 21

Description—Spores 6-7 celled, uniseriate, inaperturate, light brown, fusiform, 66-70 \times 28-34 μm . Cells of either ends smaller, triangular, with pointed ends; central cells larger, almost rectangular. Septa conspicuous with triangular septal folds of 4.5 μm high, with a pore in the centre. Spore wall 1.5 μm thick, psilate. Hyphal attachment of 6 μm long is seen at the basal end of the spore body.

Dictyosporium spore Type 1

Pl. 1, Fig. 23

Description—Broadly elliptical, olive-brown, multicellate, psilate fungal spores; 20-25 \times 10-14 μm . Spore with both the horizontal as well as vertical septa, about 2 μm thick. Spore wall 1.5 μm thick.

Dictyosporium spore Type 2

Pl. 1, Fig. 24

Description—Curved-elliptic, light-brown, multicellate biseriate, fungal spores; 38-41 \times 12-14 μm . Septa in a regular alignment, 2 μm thick. Each row 7-8 celled on exposed facet. Each cell rectangular (8 \times 4 μm) in outline. Spore wall 1.5-2 μm thick, psilate.

Genus—*MELIOLA* Fries, 1825

Meliola sp.

Pl. 1, Fig. 25

Description—Melanin coloured, 5-celled, barrel-shaped fungal spores; 40-42 μm long,

20-22 μm wide. Central cells (20×6) μm) rectangular; basal and terminal cells dome-shaped, septa 2 μm thick. Spore wall 1.5-2 μm thick, psilate.

Genus—*INVOLUTISPORONITES* Clarke, 1965 emend. Elsik, 1968

Type species—*I. wilcoxii* Elsik, 1968

Involutisporonites sp.

Pl. 1, Fig. 26

Description—Tetracellate, coiled, dark-brown, monoporate, psilate fungal spores; 22-25 μm long, 10-12 μm wide. Basal cell hemispherical, large (14×10 μm), apical cell small (4×4 μm), porate, pore slit-like, rounded. Apical and penultimate cell together forming a beak-like curved structure; spore wall 2 μm thick.

Comments—It is a rare element of the present study. It was recorded earlier by Kar, Singh and Sah (1972) from the Tura Formation of Garo hills of Assam. Our specimens closely resemble those recorded from the Rockdale lignite of U. S. A. by Elsik (1968).

Genus—*CUCURBITARIACEITES* Kar, Singh & Sah, 1972

Type species—*C. bellus* Kar, Singh & Sah, 1972

Cucurbitariaceites keralaensis sp. nov.

Pl. 1, Fig. 29

Holotype—Pl. 1, Fig. 29; TCK(6) ; 80.4×12.6 (87.5 μm).

Type Locality—Tonakkal, Kerala, India.

Diagnosis—Pseudoperithecia, sub-circular to circular, dark-brown, 86-90 μm in diameter. Outer region light-brown, characteristically very wide (about 28-32 μm), uneven, with microreticulate ornamentation, imparting a mesh-like appearance to the peripheral zone. Central part conspicuously small, circular in out-line, about 20-26 μm in diameter, with radiating lines of adpressed asci running from the radius to the periphery of the central part. Central part darker than the peripheral region.

Comments—*Cucurbitariaceites keralaensis* sp. nov. can be recognised by its conspicuously small dark-brown, translucent central region with radiating adpressed asci; and the large, mesh-like light brown peripheral region.

The specific name is after the state in which the locality is situated. It is a rarely encountered taxon in the present study.

Affinity—Pseudosphaeriales (Ascomycetes).

Hyphal Type—A

Pl. 1, Fig. 30

Description—Fungal hyphae, thick-walled, unicelled, acicular, 206-220 μm long and 3.5 μm wide. Dark-brown in colour; hyphal wall 1.5 μm thick. Terminal end sharply pointed, in some it is curved, basal portion of the hyphae are flat, discoid, hepteron-like, about 6-8 μm wide.

Comments—This type of fungal hyphae is very frequently encountered in the samples studied.

The following is the check list of other fungal spore types encountered in the Tonakkal clays :

Inapertisporites kedvesii Elsik, 1968; *Scleroderma echinosporites* Rouse, 1962; *Monoporisporites stoverii* Elsik, 1968; *M. koenigii* Elsik, 1968; *M. annulatus* Sheffy & Dilcher, 1971; *M. keralensis* Ramanujam & Rao, 1978; *Lacrimasporonites basidii* Elsik, 1968; *Dyadosporonites schwabii* Elsik, 1968; *D. denticulatus* Ramanujam & Rao, 1978; *D. kannanorensis* Ramanujam & Rao, 1978; *Fusiformisporites crabii* Rouse, 1962; *F. keralensis* Ramanujam & Rao, 1978; *Diporisporites hammenii* Elsik, 1968; *D. anklesvarensis* (Verma & Rawat) Elsik, 1968; *D. conspicua* Ramanujam & Rao, 1978; *Diporicellaesporites pluricellus* Kar & Saxena, 1976; *D. crassiseptum* Ramanujam & Srisailam, 1980; *D. attenuatus* Ramanujam & Srisailam, 1980; *D. fusiformis* Ramanujam & Srisailam, 1980; *Pluricellaesporites psilatus* Clarke, 1965; *P. alleppeyensis* Ramanujam & Rao, 1978; *P. catenatus* Ramanujam & Rao, 1978; *Tricellaesporonites triangularis* Sheffy & Dilcher, 1971; *Warkallisporonites denticulatus* Ramanujam & Rao, 1978; *Multicellaesporites ellipticus* Sheffy & Dilcher, 1971; *Meliola anfracta* Dilcher, 1965; *Brachysporisporites pyriformis* Lange & Smith, 1971; *Milesites irregularis* Ramanujam & Ramachar, 1980; *Staphlosporonites elsikii* Ramanujam & Srisailam, 1980; *Cucurbitariaceites bellus* Kar, Singh & Sah, 1972; and *Dendromyceliates splendus* Jain & Kar, 1979

Discussion

The Tonakkal assemblage of the fungal remains is represented by 22 genera and 34 species. Of these, 3 species are newly proposed. The assemblage comprises essentially the spore types of ascomycetes and dematiaceous hyphomycetes. *Meliola*, *Diporicellaesporites*, *Fusiformisporites*, *Monoporisporites*, *Diporisporites*, *Dyadosporonites* represent the ascospore types; while the *Multicellaesporites*, *Staphlosporonites*, *Brachysporites*, *Dictyosporium*, *Pluricellaesporites* and *Warkallisporonites* are referable to basidiomycetes.

From the Neogene (Miocene) strata of Kerala (Quilon and Warkalli beds), Ramanujam and Rao (1978) recorded a rich fungal assemblage consisting of *Meliola*, *Speggazzinites*, *Monoporisporites*, *Diporisporites*, *Dicellaesporites*, *Dyadosporonites*, *Multicellaesporites*, *Diporicellaesporites*, *Pluricellaesporites*, *Warkallisporonites*, *Ornasporonites*, *Cannanorosporites*, *Foveolatisporonites*, *Retihelicosporonites*, *Alleppeysporonites* and *Fusiformisporites*. Excepting *Dicellaesporites*, *Speggazzinites*, *Ornasporonites*, *Cannanorosporites*, *Foveolatisporonites*, *Retihelicosporonites* and *Alleppeysporonites* the rest of the taxa are also recorded in the Tonakkal assemblage.

Jain and Kar (1979) recorded a fungal assemblage from the Neogene sediments (Quilon & Varakala) of Kerala which include the spore genera such as *Bireticulasporis*, *Meliola*, *Inapertisporites*, *Dicellaesporites*, *Colligerites*, *Diporisporites*, *Dyadosporonites*, *Diporicellaesporites*, *Pluricellaesporites*, *Dendromyceliates* and *Lacrimasporonites*. Barring *Bireticulasporis*, *Dicellaesporites* and *Colligerites* the rest of the taxa are also known from the Tonakkal Miocene sediments.

Ramanujam and Srisailam (1980) recorded a rich fungal assemblage from the Neogene (Miocene) beds around Cannanore in Kerala. The spore genera recorded consists of *Speggazzinites*, *Isthmospora*, *Multicellaesporites*, *Meliola*, *Staphlosporonites*, *Fusiformisporites*, *Foveolatisporonites*, *Palaeocirrenalia*, *Lacrimasporonites*, *Dyadosporonites*, *Dicellaesporites*, *Diporicellaesporites*, *Palaeoamphisphaerella*, *Dictyosporium*, *Brachysporisporites*. Of these barring *Dicellaesporites*, *Foveolatisporonites*, *Palaeocirrenalia*, *Palaeoamphisphaerella* and *Isthmospora* the rest of the spore taxa recorded in Cannanore Neogene beds are also recorded in the Tonakkal assemblage.

Recently Sarma (1982) has provided a palynological data from the second mine area of the Neyveli lignite (Miocene), Tamil Nadu; and the following fungal spore genera are recorded by him, viz., *Dicellaesporites*, *Pluricellaesporites*, *Staphlosporonites*, *Brachysporisporites*, *Palaeocirrenalia*, *Multicellaesporites*, *Fusiformisporites*, *Palaeoamphisphaerella*, *Colligerties*, *Meliola*,

Ravenelites, *Milesites*. Excepting *Dicellaesporites*, *Palaeocirrenalia*, *Colligerites* *Palaeoamphisphaerella* and *Ravenelites*, the rest of the taxa are recorded in the Tonakkal fungal assemblage.

Singh and Sarkar (1984) recorded a scanty fungal assemblage from the Early Miocene Kasauli sediments (around Banethi of Himachal Pradesh). The fungal spore taxa recorded include the species of *Inapertisporites* and *Staphlosporonites*. The species of these two genera are also recorded in the Tonakkal assemblage.

More recently Pathak and Banerjee (1984) recorded the fungal remains from the Miocene sediments of the Eastern Himalayan foot hills. The fungal spores recorded include the species of *Inapertisporites*, *Monoporisporites*, *Diporisporites*, *Didymoporisporonites*, *Dicellaesporites*, *Fusiformisporites*, *Dyadosporonites*, *Multicellaesporites*, *Pluricellaesporites*, *Diporicellaesporites* and *Alternariaites*. Excepting *Dicellaesporites* and *Alternariaites* the rest of the taxa are also known from the Tonakkal clay sediments.

According to Ramanujam and Rao (1978) and Ramanujam (1982) the fungal spore types such as *Meliola*, *Pluricellaesporites*, *Warkallisporonites*, *Speggazzinites*, *Palaeoamphisphaerella*, *Ornasporonites*, *Cannanosporonites*, *Foveolatisporonites*, *Alleppeysporonites* and *Retihelicosporonites* from important markers for the Neogene (Miocene) deposits of India. Of these *Meliola*, *Pluricellaesporites* (*P. alleppeyensis*), *Warkallisporonites* (*W. denticulatus*) spore types are recorded in the Tonakkal fungal assemblage.

Thus the Tonakkal Tertiary fungal assemblage shows a number of forms similar to those recorded earlier from the Miocene Quilon, Warkalli sediments and the Neyveli lignite of South India and the eastern Himalayan foot hills of West Bengal which indicate a correlatable stratigraphic horizon.

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Explanation of Plate

(Unless otherwise mentioned all the photomicrographs enlarged ca. x 500)

1. *Inapertisporites* sp.
2. *Lacrimasporonites basidii* (x 450)
3. *Basidiosporites* sp.
4. *Didymoporisporonites* sp. (x 600)
5. Spore Type-A
6. Spore Type-B (x 450)
7. *Dyadosporonites inaequalis* sp. nov.
- 8, 9. *Fusiformisporites crabii*
10. *Fusiformisporites* sp.
11. *Fusiformisporites tonakkalense* sp. nov.
12. *Diporisporites hammenii*
13. *D. anleswarensis*
- 14-16. *Diporicellaesporites pluricellus* (x 600)
17. *D. fusiformis*
18. *Diporicellaesporites* sp.
19. *Pluricellaesporites* sp.
20. *P. psillatus*
21. *Multicellaesporites* sp. (x 600)
22. *Tricellaesporonites triangularis*
23. *Dictyosporium* spore type-1
24. *Dictyosporium* spore type-2
25. *Meliola* sp. (x 450)
26. *Involutisporonites* sp.
- 27, 28. *Cucurbitariaceites bellus* (x 400)
29. *Cucurbitariaceites keralaensis* sp. nov. (x 400)
30. Hyphal type-A (x 250)
31. *Dendromyceliates splendus* (x 400)

